REMARKS

Claims 1-29 were pending. Claims 1-23, 27, and 28 were canceled. Claims 24-26 and 29 have been amended. New claim 30 has been added. Reexamination and reconsideration of the present application is respectfully requested.

At the outset, Applicants thank the Examiner for the thorough review and consideration of the present application. The Examiner's Office Action dated June 26, 2003 has been received and the contents carefully noted.

The specification has been amended to correct minor grammatical informalities. No new matter has been added.

The Examiner rejected claims 24-26 and 28 under 35 USC 102(b) as being anticipated by Dmitriev et al. (US Patent No. 5,679,153). The rejection is respectfully traversed.

Claim 24 is allowable at least for the reason that claim 24 recites a combination of features including, for example,

> "...an opening ~~whose~~ connected with the micro-pipe and having a diameter that increases ~~as being~~ closer to a front surface of said ~~substrate~~ silicon carbide single crystal body, and a plurality of steps are formed on a wall surface of the opening of the silicon carbide single crystal body, ..." [emphasis added]

Claim 26 is allowable at least for the reason that claim 26 recites a combination of features including, for example,

> "...wherein the conductive silicon carbide substrate body has low resistivity and the silicon carbide epitaxial film has high resistivity." [emphasis added]

None of the cited references teaches or suggests each and every element of the claims.

In the present invention, micro-pipe defects exist in a SiC single crystal substrate. The micro-pipe includes an opening that increases towards a front surface of the silicon carbide substrate. When a diameter in the opening of the micro-pipe has a size of twice or more as large as than that before the diameter is enlarged, sublimation gas can be supplied sufficiently, so that the growth at the opening is possible.

The micro-pipe can be easily occluded since a plurality of steps can be formed at the opening, and a growth of a silicon carbide film in a lateral direction progresses while the steps serve as cores. Therefore, the micro-pipe can be easily occluded. When the micro-pipe is occluded (or terminated) at a conductive region disposed between the silicon carbide substrate body and an epitaxial film, and devices are formed in the substrate, in a case where a voltage is applied so as to expand a depletion layer, the depletion layer that is expanded from the epitaxial layer is restrained from being expanded by the conductive region so that the depletion layer is prevented form reaching the micro-pipe. Therefore, electric field concentration at the micro-pipe, which is caused by the phenomenon in which the depletion layer reaches the micro-pipe, is suppressed so that a breakdown due to the micro-pipe can be prevented.

The conductive region may be a conductive substrate, or may exist in the epitaxial film. Otherwise, the conductive region is a low resistivity epitaxial film. In this case, the depletion layer expanding from a high resistivity epitaxial film formed on the low resistivity epitaxial film is restrained from expanding by the low resistivity epitaxial film. As a result, the breakdown due to the micro-pipe is prevented.

The Dmitriev et al. disclosure discusses a method for reducing micropipe formation in the epitaxial growth of silicon carbide and resulting silicon carbide structures. A first epitaxial layer of silicon carbide is formed on a substrate until the

layer has a thickness sufficient to close micropipe defects propagated by the substrate into the growth of the first epitaxial layer so that the reproduction of micropipe defects is substantially reduced, and potentially entirely eliminated, in the melt growth of the first epitaxial layer. An electronically active region for device formation is formed, and a second epitaxial layer of silicon carbide is formed on the first epitaxial layer of silicon carbide.

However, Dmitriev et al. fails to teach or suggest each and every element recited in claim 24, namely, an opening connected with the micro-pipe and having a diameter that increases closer to a front surface of said silicon carbide single crystal body, and a plurality of steps formed on a wall surface of the opening of the silicon carbide single crystal body. Dmitriev et al. also fails to teach or suggest each and every element recited in claim 26, namely, a conductive silicon carbide substrate body having low resistivity and the silicon carbide epitaxial film having high resistivity.

Instead, Dmitriev et al. teaches that a micropipe is a tubular void with a diameter ranging from a few microns to as high as 0.1 mm that extends along the growth direction. *See* column 2, lines 3-15. It appears that the micropipe in Dmitriev et al. has a generally constant diameter having a range of a few microns to 0.1 mm and there is no mention of steps formed on a wall surface of the opening as shown in Figures 7B, 8A, and 8B of the present invention.

Additionally, Dmitriev et al. teaches that growth time can be varied in the range of from about 30 to 240 minutes (one-half hour to four hours) depending upon the growth temperature and the melt composition in order to keep the thickness of the epitaxial layer on the order of between about 10 and 50 microns. There is no mention

that the conductive silicon carbide substrate body has a low resistivity and the silicon carbide epitaxial film has a high resistivity as in the present invention.

Therefore, as the cited reference fails to anticipate the present invention as recited in independent claims 24 and 26, Applicants respectfully request that the rejection under 35 USC 102(b) be withdrawn.

Moreover, as claim 25 depends from independent claim 24, this claim is also allowable for the same reasons as its respective base claim. The rejection of claim 28 is deemed moot in view of the cancellation of this claim.

The Examiner rejected claims 24-28 under 35 USC 102(e) as being anticipated by Okamoto et al. (US Patent No. 5,679,153). The rejection is respectfully traversed.

Claim 24 is allowable at least for the reason that claim 24 recites a combination of features including, for example,

> "...an opening ~~whose~~ connected with the micro-pipe and having a diameter that increases ~~as being~~ closer to a front surface of said ~~substrate~~ silicon carbide single crystal body, and a plurality of steps are formed on a wall surface of the opening of the silicon carbide single crystal body, ..." [emphasis added]

Claim 26 is allowable at least for the reason that claim 26 recites a combination of features including, for example,

> "...wherein the conductive silicon carbide substrate body has low resistivity and the silicon carbide epitaxial film has high resistivity." [emphasis added]

None of the cited references teaches or suggests each and every element of the claims.

A summary of the present invention has been discussed above.

The Okamoto et al. disclosure discusses a method of manufacturing silicon carbide single crystal. Micropipe defects existing in a silicon carbide single crystal are closed within the single crystal. At least ~~a portion~~ some of the micropipe defects opened on the surface of the silicon carbide single crystal (SiC substrate) are sealed with a coating material. Heat treatment is then performed so as to saturate the inside of the micropipe defects with silicon carbide vapors. The micropipe defects existing in the SiC substrate can thus be closed within the SiC substrate, not in a newly grown layer. Further, the micropipe defects can be efficiently closed by filling the micropipe defects with a silicon carbide material by preliminarily using super critical fluid and the like.

However, Okamoto et al. fails to teach or suggest each and every element of claim 24, namely, an opening which is connected with the micro-pipe, a diameter of the opening increases closer to a front surface of said silicon carbide single crystal body, and a plurality of steps are formed on a wall surface of the opening of the silicon carbide single crystal body. Okamoto et al. also fails to teach or suggest each and every element recited in claim 26, namely, wherein the conductive silicon carbide substrate body has low resistivity and the silicon carbide epitaxial film has high resistivity.

Instead, Okamoto et al. teaches that when an SiC single crystal is produced by the modified Lely method (sublimation method) using an SiC single crystal as a seed crystal, hollow tubes called micropipe defects with a diameter ranging from sub-microns to several microns are extended approximately along the growth direction, and contained in a grown crystal. *See* column 1, lines 13-28. . It appears that the micropipe in Okamoto et al. has a generally constant diameter having a range of a sub-microns to

several microns and there is no mention of steps formed on a wall surface of the opening as shown in Figures 7B, 8A, and 8B of the present invention.

Additionally, Okamoto et al. a SiC substrate 1, which contains micropipe defects 6 has a 3C-SiC epitaxial film formed thereon. There is no mention that the conductive silicon carbide substrate body has a low resistivity and the silicon carbide epitaxial film has a high resistivity as in the present invention.

Therefore, as the cited reference fails to anticipate the present invention as recited in independent claims 24 and 26, Applicants respectfully request that the rejection under 35 USC 102(b) be withdrawn.

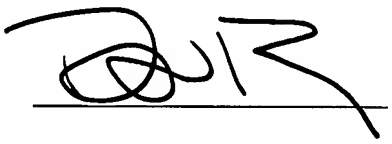
Moreover, as claim 25 depends from independent claim 24, this claim is also allowable for the same reasons as its respective base claim. The rejection of claims 27 and 28 is deemed moot in view of the cancellation of these claims.

Claim 29 was objected to as being dependent on a rejected base claim, but as being allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Regarding the objection, as claim 29 has been rewritten in independent form and in a manner that places the claim in better claim format, Applicants respectfully request that the objection be withdrawn.

Newly added dependent claim 30 further limits independent claim 29 by reciting further features regarding the low resistivity silicon carbide epitaxial film. Applicants respectfully submit that new claim 30 is allowable over the cited references.

In view of the above remarks, the present application is believed to be in condition for allowance. A prompt notice to that effect is respectfully requested. A petition for a two-month extension of time and a check for the requisite extension fee are enclosed. Although no additional fees are believed to be due, permission is hereby given to charge any unforeseen fees to deposit account 50-1147.

Respectfully submitted,



David G. Posz
Reg. No. 37,701
Customer No. 23400

DGP/TMA/yf

Posz & Bethards, PLC
11250 Roger Bacon Drive
Suite 10
Reston, VA 20190
(703) 707-9110